

## New species of *Paratullbergia* and *Pongeiella* (Collembola: Tullbergiidae) from northwest China

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**Abstract:** Two new species of Tullbergiidae, *Paratullbergia qilianensis* sp. nov. from Gansu and *Pongeiella yinchuanensis* sp. nov. from Ningxia, northwest China are described. *Paratullbergia qilianensis* is characterized by the presence of one pair of pseudocelli on thoracic segment I, with two pairs of pseudocelli on each of thoracic segments II and III, seta px present on abdominal segment IV, setae a2 and p4 on abdominal segment V as macrosetae, and a less differentiated sensillum p3 on abdominal segment V. *Pongeiella yinchuanensis* is characterized by the pseudocelli of type III, the presence of seta p3 on Th. II and III, five thickened sensilla on Ant. IV with four of them having distinct basal heels and seta oc2 on head as macroseta.

**Key words:** springtail; pseudocelli; postantennal organ; chaetotaxy; taxonomy

中国西北地区副土蟧属和庞氏土蟧属二新种记述（弹尾纲：土蟧科）

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**摘要:** 记述采自甘肃和宁夏的土蟧科 2 新种: 祁连山副土蟧 *Paratullbergia qilianensis* sp. nov. 和银川庞氏土蟧 *Pongeiella yinchuanensis* sp. nov.。祁连山副土蟧的主要特征是前胸背板上有 1+1 假眼, 中、后胸背板各有 2+2 假眼, 第 IV 腹节背板有 px 毛, 第 V 腹节背板 a2 和 p4 毛为大毛, 感觉毛 p3 分化较弱。银川庞氏土蟧的主要特征是体表假眼为 III 型, 中、后胸背板均有 p3 毛, 触角第 IV 节有 5 个感器, 其中 4 个有明显的基部后跟, 头部刚毛 oc2 为大毛。

**关键词:** 跳虫; 假眼; 角后器; 毛序; 分类

### Introduction

The family Tullbergiidae Bagnall, 1947 have 232 species previously reported in the world (Bellinger *et al.* 1996–2019). Only eight species have been recorded in China (Bu *et al.* 2013; Bu & Gao 2015, 2017a, b, 2019; Gao 2007; Rusek 1967; Tamura & Zhao 1996). During the study of the collembolan specimens from Gansu and Ningxia in northwest China, two new species of genera *Paratullbergia* Womersley, 1930 and *Pongeiella* Rusek, 1991 were

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identified and are described in the present paper.

## Material and methods

Specimens were collected by Berlese-Tullgren funnels and preserved in 80% ethanol. The material was mounted in Hoyer's solution and dried in an oven at 50°C for identification. Observations were made with a phase contrast microscope (Leica DM 2500). Drawings were done under a microscope with a drawing tube. Descriptions of pseudocelli on the body are follow Dunger and Schlitt (2011).

Abbreviations used in the descriptions: Th. – thoracic segment, Abd. – abdominal segment, Ant. – antennal segment, Asp. – anal spine, s – sensillum, PAO – postantennal organ, a – anterior setae, m – medial setae, ms – microsensillum, p – posterior setae, pl – pleural setae, pso – pseudocelli, px – central seta of posterior row.

## Taxonomy

### Family Tullbergiidae Bagnall, 1947

#### Genus *Paratullbergia* Womersley, 1930

*Paratullbergia* Womersley, 1930: 149. Type species: *Paratullbergia concolor* Womersley, 1930.

Diagnosis. The habitus is similar to that of the genus *Mesaphorura* Rusek, 1973, with some species being robust, and having an integument with coarse granulation, antennal segment IV with 2 subapical sensory rods, antennal segment III with two large sensory clubs, bent towards one another and two small sensory rods, postantennal organ with 35–68 vesicles arranged in 2–4 rows, and pseudocelli of type IV and type I. Asp thicker and longer than in *Mesaphorura*.

Distribution. China; Holarctic; India; South Africa; Australia.

#### 1. *Paratullbergia qilianensis* sp. nov. (Figs. 1–6, Tables 1, 2)

**Holotype.** ♀, (slide No. QLS-1), **Northwest China**, Gansu Province, Jiuquan City, Qilian Mountain, 39°24' N 98°28'E, elev. 2100 m, soil samples from coniferous forest, 24-V-2006, collected by Yun BU, Yan GAO & Yun Xia LUAN; **Paratypes.** 12♀ (slides Nos. QLS-1–QLS-6), same data as holotype, 1♀ (slide No. NX-LPS-2009002), 1♂ (slide No. NX-LPS-2009003), Ningxia, Liupan Mountain, 35°22'N 106°20'E, elev. 2000 m, 14-VII-2009, collected by Chengwangw Huang & Wanjun Chen. All type specimens are deposited in Shanghai Natural History Museum (SNHM).

Diagnosis. *Paratullbergia qilianensis* sp. nov. is characterized by the presence of one pair of pseudocelli on Th. I, two pairs of pseudocelli on each of Th. II and III, seta px on Abd. IV, setae a2 and p4 on Abd. V as macrosetae, and less differentiated sensillum p3 on Abd. V.

Description. Adult body 0.95 mm long on average (0.8–1.16 mm,  $n = 15$ ). Dorsal setae well differentiated into micro- and macrosetae (Figs. 1, 5). Granulations coarse, formed by secondary granules, 2.5–3.5 µm in diameter. Pseudocelli formula as 11/122/11111 from head to abdomen, 6–10 µm in diameter, type IV on antennal base, Th. II, III, and Abd. I–V, composed by 3–4 ridges from one side only (Fig. 2); type I on posterior head, Th. I, sometimes on Th. II. On Th. I posterior to seta m2, and close to hind margin; on Th. II and III, each with

two pairs of pso between setae m4/m5, p3/p4 respectively; on Abd. I–III posterior to seta p3, on Abd. IV close to seta p3, on Abd. V between the borders of Abd. V and VI (Figs. 1, 5).



Figures 1–4. *Paratullbergia qilianensis* sp. nov., holotype. 1. Head and thorax, dorsal-lateral view; 2. Postantennal organ and pseudocelli; 3. Antennal segments III and IV; 4. Leg III. a, b, c, d, e – large sensilla; ms – microsensillum; or – subapical organite; vs – apical vesicles; sc – sensory clubs; sr – sensory rods; vsc – ventral sensory club; Scale bars = 20  $\mu$ m.

Cephalic seta a0 present (22–28  $\mu$ m), c1 absent, oc2 as macroseta (33–35  $\mu$ m), and sd5 as mesoseta (25–27  $\mu$ m). Postantennal organ 30–35  $\mu$ m long and 7–8  $\mu$ m wide, composed of 32–56 oblong vesicles arranged in two rows (Fig. 2). Labrum with 4/5/4 setae. Labium with 5

papilla, 6 apical guard setae, 6 proximal setae, 4 basomedian setae, and 5 basolateral setae.



Figures 5, 6. *Paratullbergia qilianensis* sp. nov., Holotype. 5. Abdomen, dorsal-lateral view; 6. Abdomen, ventral view. Scale bar = 20 μm.

Antenna (115–130 μm) shorter than head (140–165 μm). Antennal segment IV (Fig. 3) with five slightly thickened sensilla a–e, without basal heel, sensilla a, c, e long and curved toward inside, b and d short. Small microsensillum and subapical organite and one large apical vesicle present. Antennal organ III (Fig. 3) consists of two small sensory rods concealed behind one large papilla and two thick sensory clubs bent toward each other, with four guard setae.

Legs short, without clavate tibiotarsal hairs (Fig. 4). Coxa, trochanter, femur and tibiotarsus with 3/7/7; 6/6/5; 10/10/10; 15/15/14 setae on Leg I, II and III, respectively. Anal lobes with seta 12' and 13' (Fig. 6). Claw 20–25 μm long, with distinct empodial appendage (4–5 μm). Anal spines 30–35 μm long.

Adult chaetotaxy given in Figs. 1, 5 and Table 1. Microsensilla present on Th. II–III, and lateral sensilla 37–40  $\mu\text{m}$  long (Fig. 1). Thorax with 0, 2, 2 ventral setae. Abd. I–III with 2+2 axial setae each, with setae m3 and m4. Abd. IV with seta px, m2 and m3 present. Abdominal segment V with sensilla p3 slightly differentiated, 28–43  $\mu\text{m}$  in length; seta a2 (55–58  $\mu\text{m}$ ) and p4 (42–45  $\mu\text{m}$ ) as macrosetae (Fig. 5). Crescentic ridges on abdominal segment VI present.

**Table 1. Adult chaetotaxy of *Paratullbergia qilianensis* sp. nov. (holotype)**

		Thorax			Abdomen				
Segments		I	II	III	I	II	III	IV	V
Dorsal	a	-	10	10	10	10	10	10	10 <sup>4</sup>
	m	8	8	8	4 <sup>1</sup>	4 <sup>1</sup>	4 <sup>1</sup>	4 <sup>2</sup>	-
	p	-	8	8	10	10	10	11 <sup>3</sup>	8 <sup>5</sup>
	pl	2	3	3	2	3	3	6	2
Ventral		0	2	2	12	20	23	26	10+(7+2)+4 <sup>6</sup>

<sup>1</sup> seta m3 and m4 present; <sup>2</sup> seta m2 and m3 present; <sup>3</sup> seta px present; <sup>4</sup> seta a2 as macroseta; <sup>5</sup> sensillum p3 slightly differentiated, seta p4 as macroseta; <sup>6</sup> female genital plate with 7 circumgenital and one pair of eugenital setae.

Number of ventral setae on Abd. II, III and IV variable, with 16–18, 20–23, and 26–30 setae respectively. Ventral tube with 4+4 apical setae and 2+2 basal setae (Fig. 6). Female genital plate with 5 pairs of pregenital setae, 7 circumgenital setae, one pair of eugenital setae and 2 pairs of post-genital setae (Fig. 6). Male genital plate with 5 pairs of pregenital setae, 14 pairs of circumgenital setae and 2 pairs of post-genital setae.

Etymology. The species is named after one of the type localities, Qilian Mountain.

Distribution. Northwest China (Gansu, Ningxia).

Remarks. The genus *Paratullbergia* contains nine species in the world and only one species was recorded in China (Bu & Gao, 2015; Bellinger *et al.* 1996–2019). According to the latest key modified by Bu and Gao (2015), *P. qilianensis* sp. nov. is similar to *P. changfengensis* Bu & Gao, 2015 from Shanghai in the presence of 1+1 pseudocelli on Th. I, but differs in the shape and length of setae a2 and p4 on Abd. V (macrosetae in *P. qilianensis* sp. nov., vs. microsetae in *P. changfengensis*), numbers of papilla on Ant. III (one large papilla in *P. qilianensis* sp. nov., vs. two lower papillae in *P. changfengensis*), as well as the types of pso on the body (type IV dominant in *P. qilianensis* sp. nov., vs. type I dominant in *P. changfengensis*) (Table 2).

**Table 2. Comparison of *P. qilianensis* sp. nov. and *P. changfengensis* Bu & Gao**

Characters	<i>P. qilianensis</i> sp. nov.	<i>P. changfengensis</i> Bu & Gao
Average body length (mm)	0.95	0.85
Pso formula	11/122/11111	11/122/11111
Dominant types of pso	type IV	type I
Number of PAO vesicles	32–56	32–47
Number of papilla on Ant. III	one	two
Length of sensilla p3 on Abd. V ( $\mu\text{m}$ )	28–43	22–29
Length of seta a2 on Abb. V ( $\mu\text{m}$ )	55–58	15–16
Length of seta p4 on Abb. V ( $\mu\text{m}$ )	42–45	19–21

## Genus *Pongeiella* Rusek, 1991

*Pongeiella* Rusek, 1991, pp. 65. Type species: *Tullbergia falca* Christiansen & Bellinger, 1980.

**Diagnosis.** The genus *Pongeiella* is characterized by the pseudocelli with crescentic lid (type III), sensilla on antennal segment IV with basal heel, secondary granules on the body, absence of crescentic ridges on abdominal segment VI and the absence of setae m2 on thoracic segments II and III.

**Distribution.** China; Canada; France; Bulgaria; Albania.

### 2. *Pongeiella yinchuanensis* sp. nov. (Figs. 7–12, Tables 3, 4)

**Holotype.** ♀ (slide No. Yinchuan-1), **Northwest China**, Ningxia, Yinchuan City, Zhongshan Park, 38°28' N 106°15'E, elev. 1000 m, soil samples from mixed forest, 02-VI-2006, collected by Yun BU, Yan GAO & Yunxia LUAN. **Paratype.** 1♀ (slide No. Yinchuan-2), same as holotype. Type specimens are deposited in SNHM.

**Diagnosis.** *Pongeiella yinchuanensis* sp. nov. is characterized by the pseudocelli of type III, postantennal organ composed of 35 vesicles, with 2 round vesicles inserted between two rows, presence of seta p2 on Th. II and III, five thickened sensilla on Ant. IV with four of them having distinct basal heels, seta oc2 on head as macroseta, without setae a0, v0 and v1 on head, presence of seta a2 on Abd. V and presence of setae l2' and l3' on anal lobe.

**Description.** Adult body 0.55 mm long in average ( $n = 2$ ). Dorsal setae well differentiated into micro- and macrosetae (Figs. 7, 11). Granulations coarse, formed by secondary granules. Ventral median area of Abd. IV also with secondary granules. Pseudocelli formula as 11/011/11111 from head to abdomen, 8–10 µm in diameter, and covered by a semicircular lid, inner edge thickened lip-like (type III) (Figs. 8, 9). Pseudocelli on Th. II and III between setae p3 and p4, on Abd. I–V posterior to seta p3 (Figs. 7, 11).

Head without seta a0, seta c1 absent, seta oc2 as macroseta (20 µm), seta v0 and v1 absent (Fig. 7). Postantennal organ 20 µm long and 6 µm wide, composed of 35 elliptic vesicles arranged in two rows, with 2 round vesicles inserted between two rows (Fig. 8). Labrum and labium not studied in detail.

**Table 3. Adult chaetotaxy of *Pongeiella yinchuanensis* sp. nov. (holotype)**

		Thorax			Abdomen				
Segments		I	II	III	I	II	III	IV	V
Dorsal	a	-	10	10	10	10	10	10	8 <sup>3</sup>
	m	8	6 <sup>1</sup>	6 <sup>1</sup>	-	-	-	-	-
	p	-	10 <sup>2</sup>	10 <sup>2</sup>	10	10	10	10	8 <sup>4</sup>
	pl	2	3	3	2	3	3	6	1
Ventral		0	2	2	12	15	18	24	11+(5)+4 <sup>5</sup>

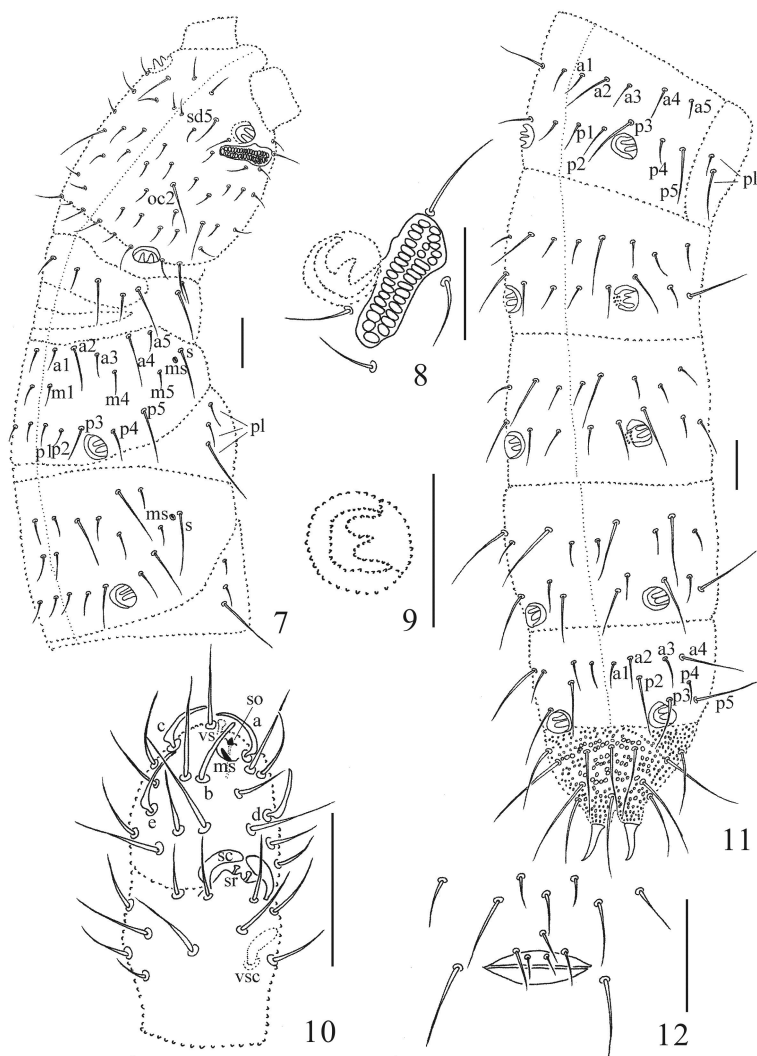
<sup>1</sup> seta m2 and m3 absent; <sup>2</sup> seta p2 present; <sup>3</sup> seta a5 absent, seta a2 as microseta; <sup>4</sup> sensillum p3 slender, seta p4 as microseta; <sup>5</sup> female genital plate with 3 circumgenital and one pair of eugenital setae

Antenna (75 µm) shorter than head (95 µm). Antennal segment IV (Fig. 10) with five thickened sensilla a–e, four of them (a, c, d, e) with distinct basal heel, b cylindrical, small microsensillum, subapical organite and one small apical vesicles present. Antennal organ III (Fig. 10) consists of two small sensory rods concealed behind one low papilla and two thick sensory clubs bent toward each other, with four guard setae.

Legs short, without clavate tibiotarsal hairs. Tibiotarsus I, II and III with 12/12/12 setae. Anal lobes with setae 12' and 13'. Claw 12  $\mu\text{m}$  long, with short empodial appendage (3  $\mu\text{m}$ ). Anal spines 15  $\mu\text{m}$  long, on high papillae.

Adult chaetotaxy given in Figs. 7, 11 and Table 3. Microsensilla present on Th. II–III, and lateral sensilla s 26  $\mu\text{m}$  long (Fig. 13). Thorax with 0, 2, 2 ventral setae. Abd. I–III with 2+2 axial setae each, without middle setae. Abd. IV without seta px, middle setae absent. Abdominal segment V with sensilla p3 slender, 22  $\mu\text{m}$  long; seta a2 (14  $\mu\text{m}$ ) and p4 (15  $\mu\text{m}$ ) as microsetae (Fig. 11).

Ventral tube with 4+4 apical setae and 2+2 basal setae. Female genital plate with 11 pregenital setae, 3 circumgenital, one pair of eugenital setae and 2 pairs of post-genital setae (Fig. 12).



Figures 7–12. *Pongeiella yinchuanensis* sp. nov., holotype. 7. Head and thorax, dorsal-lateral view; 8. Postantennal organ and pseudocelli; 9. Pseudocelli on abdominal segment V; 10. Antennal segments III and IV; 11. Abdomen, dorsal view. 12. Female genital plate. a, b, c, d, e – large sensilla, ms – microsensillum, or – subapical organite, vs – apical vesicles, sc – sensory clubs, sr – sensory rods vsc – ventral sensory club. Scale bars = 20  $\mu\text{m}$ .

Etymology. The species is named by the type locality, Yinchuan City.

Distribution. Northwest China (Ningxia).

Remarks. The genus *Pongeiella* contains four species (subspecies) from North America and Europe (Christiansen & Bellinger 1980; Dunger & Schlitt 2011; Pomorski & Skarzynski 1997; Rusek 1991; Thibaud & Peja 1996). In China, only one undetermined species *Pongeiella* sp. was mentioned by Zhu QG in his dissertation (Zhu 2010). *Pongeiella yinchuanensis* sp. nov. can be distinguished from all other congeners in the presence of seta p2 on both Th. II and III, more vesicles (35) on PAO than in other species, and five thickened sensilla on Ant. IV. Other differences are given in Table 4.

**Table 4. Comparison of species (subspecies) of genus *Pongeiella* Rusek worldwide**

Species	<i>P. yinchuanensis</i> sp. nov.	<i>P. falca falca</i>	<i>P. falca europea</i>	<i>P. luciaelvira</i>	<i>P. stojanovorum</i>
Distribution	China	Canada, Sweden	France	Albania	Bulgaria
Sex	only females observed	only female	only female	bisexual	bisexual
Length (mm)	0.55	0.6	0.6	0.46	0.6
Vesicles of PAO	35, 2 insertion	23–25	28	28, 3–5 insertion	27
Ant. IV	a, c, d, e with heel	a, b, c with heel	a, b, c with heel	without heel	without heel
Apical papilla on Ant. IV	+	-	-	+	+
Cephalic seta a0	-	+	+	+	+
Cephalic seta v0	-	+	-	-	-
Cephalic seta oc2	macroseta	microseta	microseta	microseta	microseta
Middle setae on Th. II and III	6	6	6	8 (m3 present)	6
Posterior setae on Th. II and III	10 (p2 present)	8 (p2 absent)	8 (p2 absent)	8 (p2 absent)	8 on Th. II, 10 on Th. III (p2 present)
Middle setae on Abd. I–IV	0	0	0	2	2 on Abd. II and III
Seta a2 on Abd. V	+	-	-	+	-
Setae l2' on anal valve	+	+	+	+	-

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